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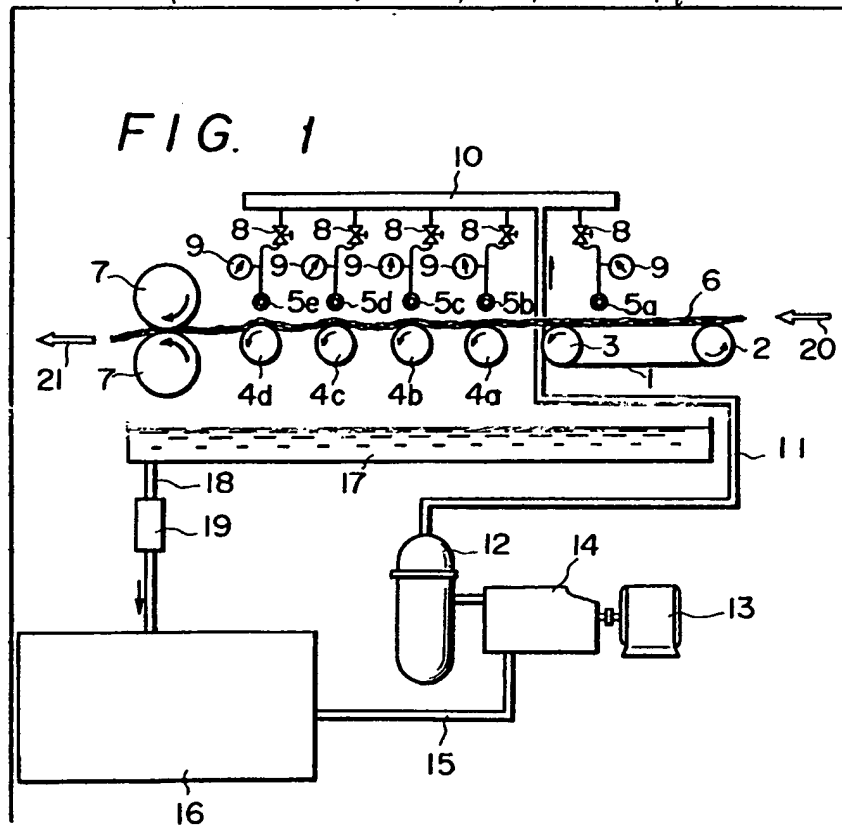
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(54) Nonwoven fabric and method for production thereof

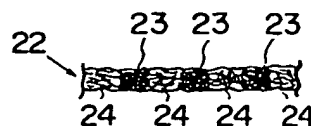
(57) A non-woven fabric containing first and second fibres comprising first zones 23 extending the length of the fabric having a relatively high density and in which the first and second fibres are interlaced, the first zones

being separated by second zones 29 of relatively low density in which the first fibres are substantially absent. The fabric may be formed by treating with fluid jets a layer of first fibres disposed on a layer of second fibres. Polyester polyolefine cotton and rayon fibres are specified.

1, 8, 9, 10, 11, 12, 13, 14, 15 - 21, 24



**FIG. 5**



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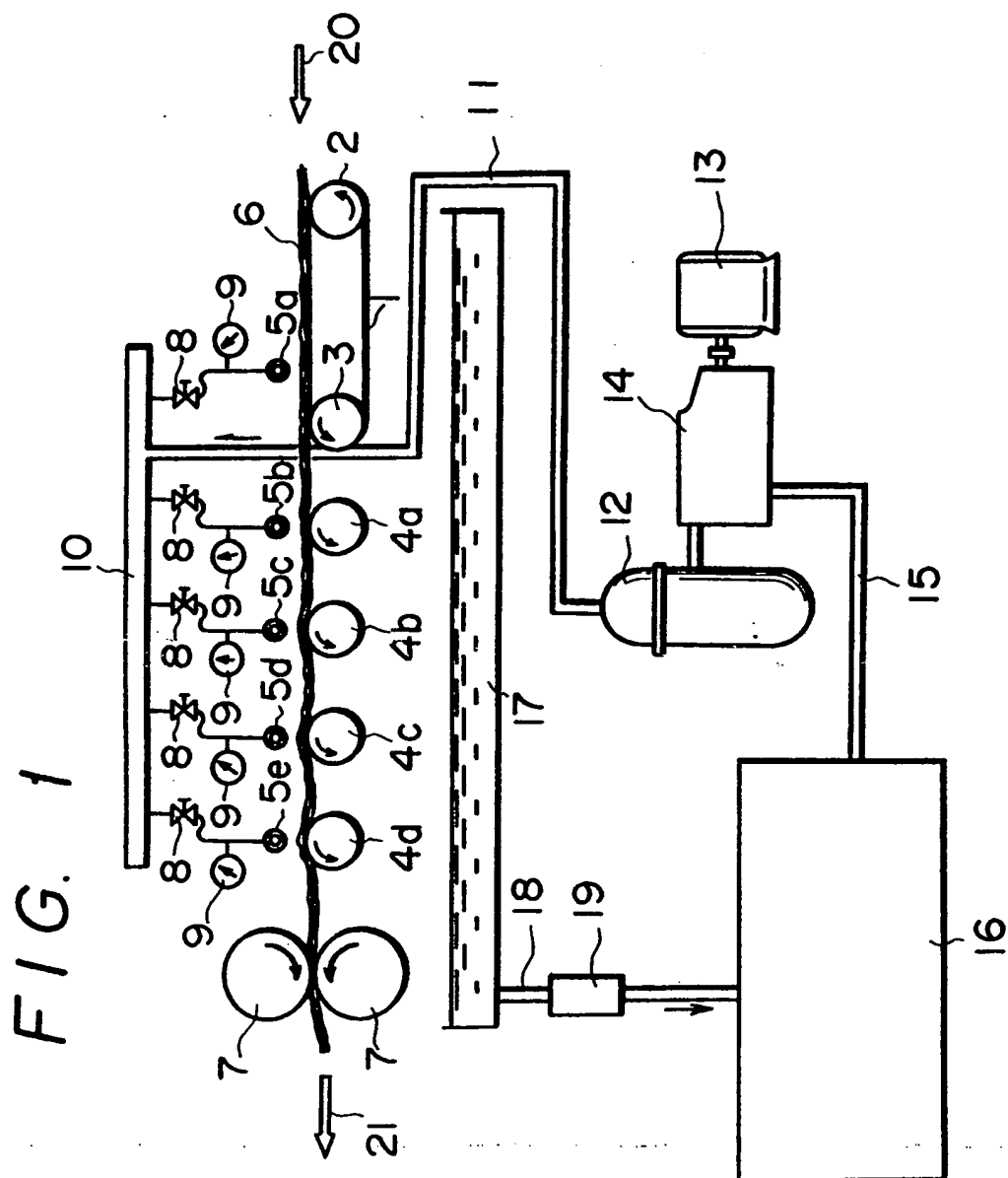


FIG. 2

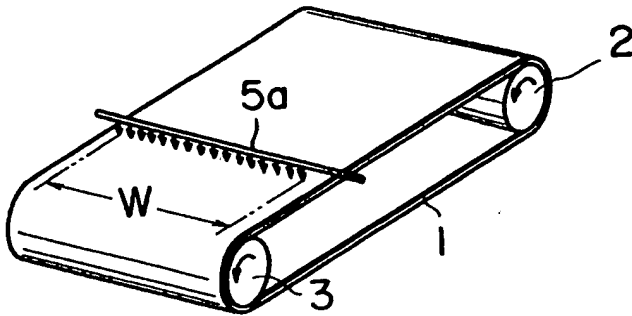


FIG. 4

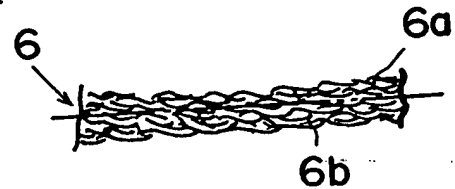


FIG. 3

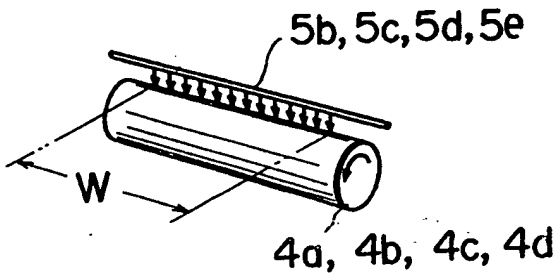


FIG. 5

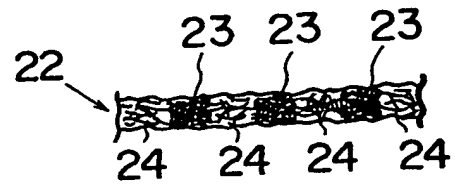


FIG. 6



FIG. 7

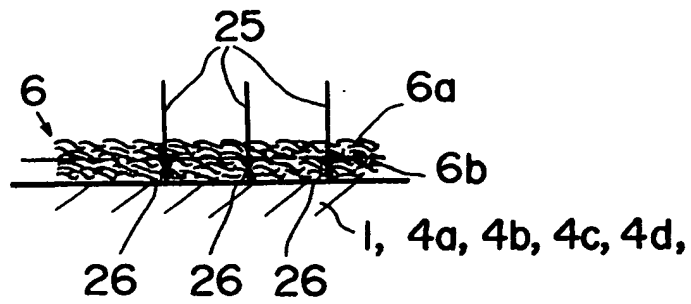
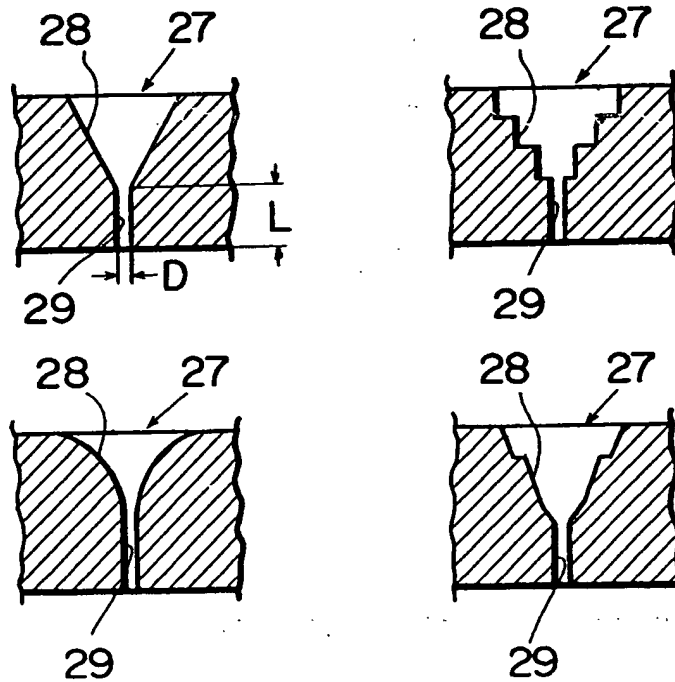


FIG. 8



## SPECIFICATION

## Nonwoven fabric and method for production thereof

The present invention relates to nonwoven fabric comprising alternately arranged stripe-like component zones having properties which are different relative to each adjacent zone and to a method for production of such nonwoven fabric.

It is well known to use nonwoven fabrics as material, particularly as the surface material for sanitary goods such as a sanitary napkin and a disposable diaper, and it has always been desired that these nonwoven fabrics conventionally used as the surface material should absorb a given quantity of body fluids at a given spot without diffusion thereof; should be kept dry even after passage of said fluids; and should prevent said fluids from flowing back. To satisfy these requirements, there have already been proposed and, in some cases, used in practice nonwoven fabrics of various types, for example, the nonwoven fabric comprising a mixture of hydrophilic fibres and hydrophobic fibres, the nonwoven fabric comprising a plurality of layers including hydrophilic fibre layers and hydrophobic fibre layers, and the nonwoven fabric comprising a hydrophilic fibre layer and a hydrophobic fibre layer, laid upon one another so that any one of these two layers is partially exposed through the other layer. However, all of these well known nonwoven fabrics have ever been unsatisfactory to meet said requirements and have disadvantages in aspects such as complicated steps and relatively high cost required for production thereof.

In accordance with the present invention, there is provided nonwoven fabric comprising alternately arranged stripe-like component zones having properties which are different relative to each adjacent zone. Such nonwoven fabric has the properties to meet said requirements that, when used as the surface material in various sanitary goods, it should absorb a given quantity of various body fluids at a given spot without diffusion of such body fluids; it should be kept dry even after passage of said liquid therethrough; and it should prevent said liquid from flowing back. Further, the nonwoven fabric according to the present invention contains no special material such as fibre binding agent and, therefore, advantageously has comfortable bulkiness, fitness, air-permeability and warm touch. Thus, the nonwoven fabric of the present invention is optimum, particularly as material for sanitary goods, as previously mentioned. In accordance with the present invention, the nonwoven fabric is formed not by using any special material such as fibre binding agent but only by utilizing a hydraulic energy of high velocity water streams for the fibre interlacing treatment and thereby the nonwoven fabric of said properties is easily mass-produced at a low cost.

A principal object of the present invention is to provide the nonwoven fabric having said properties and the method for production thereof by which such nonwoven fabric can be produced at a low cost not by using any special material such as fibre binding agent but only by utilizing hydraulic energy of high velocity water streams.

Obviously, the method by which nonwoven fabrics are produced through a treatment under hydraulic energy of high velocity water streams has already been per se well known and the present invention does not intend to provide such treatment itself.

According to the present invention, there is provided nonwoven fabric comprising first component fibres and second component fibres, said nonwoven fabric being formed of (1) the first zones arranged parallel at intervals transversely of said nonwoven fabric and respectively being continuous longitudinally of said nonwoven fabric and having a relatively high density, in which said first component fibres and said second component fibres are interlaced with each other; and (2) the second zones interposed between each pair of said first zones and having a relatively low density, in which said second component fibres are present and said first component fibres are scarcely contained.

The present invention provides also a method for production of such nonwoven fabric, said method comprising a step of subjecting the materials to be treated, i.e., the component materials of nonwoven fabric to a hydraulic energy of fine water jet streams supplied from orifices arranged at desired pitches onto a water-impermeable support on which said materials to be treated are placed and thereby the desired nonwoven fabric is formed.

The invention will now be further described by way of example, with reference to the accompanying drawings in which:

Fig. 1 is a side view schematically illustrating an apparatus for execution of the method according to the present invention;

Fig. 2 is a perspective view illustrating a first support;

Fig. 3 is a view similar to Fig. 2 illustrating a second support;

Fig. 4 is a sectional view schematically illustrating a structure of the materials to be treated;

Fig. 5 is a sectional view schematically illustrating how the first component fibres are combined with the second component fibres of the materials to be treated;

Fig. 6 is a photograph showing on an enlarged scale the structure of a nonwoven fabric obtained by the method according to the present invention;

Fig. 7 is a sectional view schematically illustrating a principle of the high velocity water streams

acting upon the materials to be treated; and

Fig. 8 is a vertical section illustrating an embodiment of the orifice arrangement.

Referring to Fig. 1, an endless belt 1 serving as a first support which is water-impermeable and has a substantially smooth surface is suspended on and extends between a pair of rolls 2, 3. There are arranged at the left side as seen in Fig. 1, rolls 4a, 4b, 4c, 4d serving as second supports and respectively having water-impermeable and substantially smooth surfaces. Above said belt 1 and the rolls 4a, 4b, 4c, 4d, there are correspondingly arranged nozzle means 5a, 5b, 5c, 5d, 5e (Figs. 2 and 3). There is arranged at the left side as seen in Fig. 1 a pair of squeezing rolls 7 for dehydration of the materials 6 to be treated. The respective nozzle means 5a, 5b, 5c, 5d, 5e are connected via associated pressure regulating valves 8 and pressure gauges 9 to a distribution reservoir 10. The distribution reservoir 10 is connected by a pipe 11 to a filter reservoir 12 which is, in turn, connected to a pressure pump 14 adapted to be driven by a motor 13. Said pump 14 is connected by a pipe 15 to a reservoir 16. In a space defined under the belt 1 and the rolls 4a, 4b, 4c, 4d, 7 there is arranged a try-like recovery tank 17 which is connected via a pipe 18 and a filter box 19 to the reservoir 16. A quantity of water within the reservoir 16 is pressurized by the pressure pump 14, filtered by the filter reservoir 12, supplied to the distribution reservoir 10, then distributed into the respective nozzle means 5a, 5b, 5c, 5d, 5e and finally jetted out through the respective orifices arranged in the bottoms of these nozzle means at desired intervals onto the associated belt 1 and rolls 4a, 4b, 4c, 4d, 4e in the form of high velocity fine water streams (Figs. 2 and 3).

In this apparatus, the materials 6 to be treated are introduced in the direction of an arrow 20 onto the belt 1 and then transported in the direction of an arrow 21 successively on the belt 1, the rolls 4a, 4b, 4c, 4d, 4e and through the squeezing rolls 7. The materials 6 to be treated are first subjected to a preliminary treatment for fibre interlacing with the high velocity water streams jetted through the orifices of the nozzle means 5a as said materials 6 are transported on the belt 1 so that the materials 6 are bestowed with a sufficient fibre interlacing effect to prevent the fibrous webs referred to below from being disturbed in its configuration or being damaged. The materials 6 to be treated are successively subjected to similar but more intensive treatment with the high velocity water streams jetted out through the orifices of the respective nozzle means 5b, 5c, 5d, 5e as said materials 6 are transported on the rolls 4a, 4b, 4c, 4d. After these preliminary and regular treatments for fibre interlacing, the materials 6 are squeezed by the rolls 7 to the extent that said materials 6 becomes substantially free from moisture and are transferred to the subsequent process for drying.

Fig. 4 illustrates a structure of the materials 6 to be treated by the method according to the present invention. The materials 6 to be treated comprise a first component fibrous web 6a and a second component fibrous web 6b laid upon one another. The first component fibrous web 6a may be formed by a card or a paper making machine so far as fibres can be displaced under the high energy of the jet streams. However, the basic weight of the first component fibrous web 6a must be less than 50 g/m<sup>2</sup> and preferably less than 25 g/m<sup>2</sup>. With a basic weight of 50 g/m<sup>2</sup> or heavier, it would be impossible to distinguish first component zones and second component zones, which will be described later. The second component fibrous web 6b also may be formed by a card or a paper making machine or other means so far as fibres can be displaced by the force of the jet streams towards the second component fibrous web 6b. Although the basic weight of the second component fibrous web 6b is not important, it is preferred that the first component fibrous web 6a and the second component fibrous web 6b totally should have a basic weight less than 100 g/m<sup>2</sup>. The present invention utilizes the first component fibrous web 6a and the second component fibrous web 6b, for example, in combination as shown by the following table, where A represents the hydrophilic fibres and B represents the hydrophobic fibres.

	1	2	3	4	5	6
First component fibrous web	A	B	A	B	AB	AB
Second component fibrous web	B	A	AB	AB	A	B

When a mixture of the hydrophilic fibres and the hydrophobic fibres is used, a mixing ratio (% by weight) may be selected depending on a particular application of the nonwoven fabric to be obtained. Where the nonwoven fabric is used as surface material for a sanitary napkin or disposable diaper, for example, it has proved to be effective that the first component fibrous web 6a comprises a mixture of rayon fibres of 50% by weight and polyester fibres of 50% by weight while the second component fibrous web 6b comprises polyester fibres of 100% by weight or the first component fibrous web 6a comprises a mixture of rayon fibres of 50% by weight and cotton fibres of 50% by weight while the second component fibrous web 6b comprises a mixture of polyester fibres of 50% by weight and polypropylene fibres of 50% by weight.

Figs. 5 and 6 illustrate the nonwoven fabric obtained by the method according to the present invention. The materials 6 to be treated comprising the first component fibrous web 6a as the upper layer laid upon the second component fibrous web 6b as the lower layer are introduced into the apparatus of Fig. 1, in which the materials 6 are subjected, on the belt 1 and the rolls 4a, 4b, 4c, 4d serving as said first support and said second support, respectively, to the fibre interlacing treatment with the high velocity water streams jetted out through the orifices arranged at a desired pitch in the bottoms of the respective nozzle means 5a, 5b, 5c, 5d associated with said belt 1 and said rolls 4a, 4b, 4c, 4d, respectively, so that the first zones 23 and the second zones 24 of the nonwoven fabric 22 are formed. The first zones 23 are arranged at intervals corresponding to the pitches of said orifices transversely of the nonwoven fabric 22 and continuously extend longitudinally of the nonwoven fabric 22 while the second zones 24 are interposed between each pair of said first zones 23. In the first zones 23, the fibres in the first component fibrous web 6a are displaced in the direction of thickness of the second component fibrous web 6b and the fibres in the first component fibrous web 6a and the fibres in the second component fibrous web 6b are interlaced with each other and thereby the first zones have a relatively high density. In the second zones 24, on the contrary, the fibres in the first component fibrous web 6a are scarcely present by virtue of being displaced into the first zones 23 and thereby the second zones have a relatively low density. In order that the first zones 23 and the second zones 24 may be distinguished from one another, the basic weight of the first component fibrous web 6a must be less than 50 g/m<sup>2</sup>, as already mentioned. The diameter of each orifice is preferably 0.05 to 0.2 mm and the pitch at which the orifices are arranged is preferably 0.5 to 10 mm to form the first zones 23 and the second zones 24 which are clearly distinguished from one another. In the embodiment as illustrated by Figs. 5 and 6, the first zones 23 are relatively narrow while the second zones 24 are relatively wide, but the present invention is not limited to this embodiment. However, it has proved to be preferable that the first zones 23 are narrower than or substantially equal to the second zones 24 when the nonwoven fabric is used as the surface material for a sanitary napkin or disposable diaper and comprises hydrophilic fibres of 50% by weight as the fibres in the first component fibrous web 6a and hydrophobic fibres of 100% by weight as the fibres in the second component fibrous web 6b, since such composition contributes to an improvement of said properties desired for the nonwoven fabric, i.e., the properties to meet the requirements that the nonwoven fabric should effectively absorb the body fluids at a given spot, remain dry even after passage of said fluids and prevent said fluids from flowing back.

Fig. 7 principally illustrates the manner in which the high velocity water streams behave during the treatment for fibres interlacing on the belt 1 and the rolls 4a, 4b, 4c, 4d. The high velocity water streams 25 penetrate the materials 6 to be treated, strike against the surface of the associated supports, i.e., said belt 1 and said rolls 4a, 4b, 4c, 4d, and rebound thereon upwards to act again upon said materials 6 to be treated. The materials 6 to be treated are thus subjected to interaction of the water jet streams 25 and their rebounding streams 26 so that the individual fibres in said materials to be treated are displaced in three-dimensional directions and thereby complicatedly, firmly and efficiently interlaced. The water streams which have lost their energy upon completion of the fibre interlacing treatment are drained along peripheries of the respective supports and partially along edges of the materials 6 to be treated which are travelling, the streams being drained into said recovery tank 17. Surface hardness of the respective supports must be sufficiently high so that the high velocity water streams may rebound on the surfaces of the respective supports and these rebounding streams may contribute again to the treatment for fibre interlacing. Accordingly, the belt 1 as said first support and the rolls 4a, 4b, 4c, 4d as said second supports should have their surface hardness, in accordance with the present invention, higher than 50°, preferably higher than 70° according to JIS (the Japanese Industrial Standards)—K 6301 Hs. Said belt 1 and said rolls 4a, 4b, 4c, 4d may be made of metal, rubber or plastics or a combination thereof, so far as they have said hardness and a strength enough to resist a pressure of the high velocity water streams. Each of said rolls 4a, 4b, 4c, 4d preferably has a diameter of 50 to 300 mm to resist the pressure of the high velocity water streams and to facilitate the drainage thereof.

Fig. 8 illustrates by way of example a structure of each orifice 27 formed in the bottom of each nozzle means 5a, 5b, 4c, 5d, 5e. The orifice 27 has a diameter 0.05 to 0.2 mm and comprises, in its vertical section, a downwardly tapering portion 28 and a linear portion 29 as seen in Fig. 8(A), (B), (C) and (D). L/D, a ratio of a length L to a diameter D of said portion 29 is smaller than 4/1, more preferably smaller than 3/1. Such configurations of the orifice 27 contribute to effective reduction of a pressure loss due to the water stream resistance. On the contrary, the orifice 27 in the form of a uniform diameter cylinder with said ratio L/D larger than 4/1 would result in an increase of the pressure loss due to the water stream resistance and a considerable economical disadvantage.

A transverse average supply of the high velocity water streams from the respective nozzle means 5a, 5b, 5c, 5d, 5e having the orifices 27 as illustrated by Fig. 8 onto the associated supports is less than 40 cc/sec-cm, more preferably, less than 30 cc/sec-cm. The value expressed herein by "transverse average supply" is given by a ratio F/W where F represents a total flux jetted out from each of the nozzle means onto one support, i.e., each of the belt 1 and the rolls 4a, 4b, 4c, 4d as shown in Figs. 1 through 3 and W represents an effective width of each nozzle means 5a, 5b, 5c, 5d, 5e. When treated with said transverse average supply of 40 cc/sec-cm or higher, the high velocity water streams jetted onto the



belt 1 and the rolls 4a, 4b, 4c, 4d would be inadequately drained and the material to be treated would be flooded with an excess of water. In consequence, the energy of the high velocity water streams which is expected to act upon the material to be treated would be suddenly reduced and the desired treatment for fibre interlacing would be seriously obstructed or the stability with which the fibrous web should be treated would be reduced, if the material 6 to be treated contains therein such fibrous web, since said fibrous web would be disturbed.

A pressure at which the high velocity water streams are jetted out, more strictly, a back pressure of the nozzle means 5a, 5b, 5c, 5d, 5e is lower than 35 kg/cm<sup>2</sup>, more preferably, 15 to 30 kg/cm<sup>2</sup>. At the back pressure of 35 kg/cm<sup>2</sup> or higher, the individual fibres in the material 6 to be treated would be displaced so far that the structure of this fibrous web is disturbed and the fibre interlacing would be uneven. At the back pressure lower than 7 kg/cm<sup>2</sup>, on the contrary, it would be impossible to produce the nonwoven fabric of the desired properties at a high efficiency, no matter how long the material to be treated is subject to the treatment with the high velocity water streams or no matter how close to the material to be treated said nozzle means are placed.

Although the present invention has been described hereinabove with reference to the nonwoven fabrics to be used as material for sanitary goods and the method for production of such nonwoven fabrics, it should be understood that the method according to the present invention may be applied to production of various nonwoven fabrics comprising, as component with properties different relative to each other, an electrically conductive component and an electrically insulative component, a dyeable component and a non-dyeable component, components of different melting points, a fusible component and an infusible component, components of different elasticities, or an elastic component and an inelastic component, depending upon the intended uses of the nonwoven fabric to be obtained.

#### EXAMPLE

Rayon fibrous web (1.5 d x 51 mm) of 10% by weight as the first component fibrous web and polyester fibrous web (1.4 d x 44 mm) of 100% by weight as the second component fibrous web were laid on one another to obtain materials to be treated of a basic weight equal to 20 g/m<sup>2</sup>. Such materials to be treated were introduced into the apparatus as illustrated in Fig. 1, in which said materials were treated at a jet pressure of 30 kg/cm<sup>2</sup> and a transverse average water supply of 8.5 cc/sec-cm of the high velocity water streams from the respective nozzle means 5a, 5b, 5c, 5d, 5e onto the supports 1, 4a, 4b, 4c, 4d as shown in Figs. 1 to 3, to obtain samples of nonwoven fabric. These samples were immersed in a boiled 1% solution of dyes which are available under the trade name "KAYASTAIN A" from NIHON KAYAKU CO., LTD., in Japan, with a result that the rayon fibres were dyed in yellow and the polyester fibres were dyed in blue. These samples exhibited characteristics as shown in the following table.

Samples No.	B.W. of 1st component fibrous web (g/m <sup>2</sup> )	Total b.w. (g/m <sup>2</sup> )	Remarks
1	10	29.8	1st zones were formed
2	20	37.6	"
3	50	68.7	1st and 2nd zones were not clearly distinguished

#### CLAIMS

1. A nonwoven fabric comprising first component fibres and second component fibres having properties which are different from each other, said nonwoven fabric comprising
  - (1) first zones arranged parallel at intervals transversely of said nonwoven fabric and respectively being continuous longitudinally of said nonwoven fabric and having a relative high density, in which said first component fibres and said second component fibres are interlaced with each other; and
  - (2) second zones interposed between each pair of said first zones and having a relatively low density, in which said first component fibres are scarcely present.
2. A nonwoven fabric as claimed in claim 1, wherein the first component fibres comprise hydrophilic fibres, and the second component fibres comprise hydrophobic fibres.
3. A nonwoven fabric as claimed in claim 1, wherein the first component fibres comprise hydrophobic fibres, and the second component fibres comprise hydrophilic fibres.
4. A method for the production of a nonwoven fabric comprising a step of subjecting materials to be treated consisting of a first component fibrous web and a second component fibrous web laid upon one another to a treatment with high velocity fine water streams jetted out through orifices of nozzle

means at a pressure lower than 35 kg/cm<sup>2</sup> onto water-impermeable supports, the respective nozzle means being so provided that said orifices of the associated nozzle means are arranged at desired pitches transversely of said materials to be treated and opposed to said first component fibrous web of said materials to be treated in such a manner that the first zones are formed at intervals corresponding to the pitches of said orifices transversely of the nonwoven fabric and continuously extend longitudinally of said nonwoven fabric, in these first zones the fibres in said first component fibrous web being displaced in the direction of thickness of said second component fibrous web and the fibres in said first component fibrous web and the fibres in said second component fibrous web being interlaced with each other; and that the second zones are formed between each pair of said first zones, in these second zones the fibres in said first component fibrous web being scarcely present by virtue of being displaced into said first zones.

5. A method as claimed in claim 4, wherein the first component fibrous web comprises hydrophilic fibres, and the second component fibrous web comprises hydrophobic fibres.

6. A method as claimed in claim 4, wherein the first component fibrous web comprises hydrophobic fibres, and the second component fibrous web comprises hydrophilic fibres.

7. A method as claimed in claim 4, wherein the first component fibrous web comprises hydrophilic fibres, and the second component fibrous web comprises hydrophilic fibres and hydrophobic fibres.

8. A method as claimed in claim 4, wherein the first component fibrous web comprises hydrophobic fibres, and the second component fibrous web comprises hydrophilic fibres and hydrophobic fibres.

9. A method as claimed in claim 4, wherein the first component fibrous web comprises hydrophilic fibres and hydrophobic fibres, and the second component fibrous web comprises hydrophilic fibres.

10. A method as claimed in claim 4, wherein the first component fibrous web comprises hydrophilic fibres and hydrophobic fibres, and the second component fibrous web comprises hydrophobic fibres.

11. A non-woven fabric as claimed in claim 1, and substantially as hereinbefore described with reference to Figs. 5 and 6 of the accompanying drawings.

12. A method as claimed in claim 4 and substantially as hereinbefore described with reference to the Example.